Vol. XLI FEBRUARY, 1958 No. 9

THE PHILIPPINE AGRICULTURIST

JOURNAL OF THE COLLEGE OF AGRICULTURE
AND CENTRAL EXPERIMENT STATION
University of the Philippines

CONTENTS

Agriculture and Industry in the Philippines ..... *W. I. Myers* 479

Chemical Composition of Some Grasses and Legumes From Different Areas in the Philippines ..... *J. K. Loosli, K. C. Beeson, N. C. Brady and E. Farinas* 486

Chemical Analyses of Cadang-Cadang-Infected Coconuts, Supposedly Healthy Palms From the Cadang-Cadang Area and Healthy Trees From the College of Agriculture Where the Disease Does Not Occur ..... *L. A. Ynalvez, R. R. Covar, and G. O. Ocfemia* 491

Dairy Qualities of Philippine Cows .... *V. Villegas and E. C. Cruz* 495

The Effect of "TM-5" (Terramycin Feed Supplement) Upon the Rate of Growth of Growing and Fattening Pigs ..... *J. A. Eusebio and R. B. Puyaoan* 499

Biological Study of *Lymantria Lunata* Cramer, (Lymantriidae, Lepidoptera), With A Consideration of Its Control ..... *E. S. Novero* 505

UNIVERSITY OF THE PHILIPPINES PUBLICATIONS SERIES A
Published at College, Laguna

COMMONWEALTH MYCOLOGICAL INSTITUTE
29 JUL 1958

The Philippine Agriculturist

Journal of the College of Agriculture and Central Experiment Station
University of the Philippines

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The Philippine Agriculturist is published monthly except in April and May by the College of Agriculture and Central Experiment Station, University of the Philippines, College, Laguna. The subscription price is ₱6.00 a year in the Philippines and $4.00 (U.S. currency) elsewhere; the price of single copies, ₱0.75 in the Philippines and $0.50 elsewhere.

Authors of articles appearing in The Philippine Agriculturist are severally responsible for the opinions expressed therein.

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AGRICULTURE AND INDUSTRY IN THE PHILIPPINES [1]

WILLIAM I. MYERS [2]

In July, 1952, the College of Agriculture of Cornell University entered into a cooperative agreement with the U.P. College of Agriculture to help strengthen the program of agricultural research and education at Los Baños. This contract was financed by the United States through M.S.A., now I.C.A., and the purpose of the program was to promote the welfare of the Philippines by increasing the output and the efficiency of agriculture.

Our first visit to the Islands was made five years ago to confer with Dean Uichanco and his colleagues and to make plans for our joint program. Last June, we renewed our agricultural contract for a three-year period and at the same time signed a similar agreement with Dean Mabesa of the neighboring College of Forestry at Los Baños. Our present trip is for the joint purpose of conferring with Harvey Pope, Resident Manager of the Insular Lumber Co. of which I am a Director, and of making plans with Deans Uichanco and Mabesa for the remaining 2½ years during which our present contracts will run.

We, at Cornell, are pleased and honored to be associated with the U.P. Colleges of Agriculture and Forestry, and with ICA in this program to strengthen the agricultural economy of the Philippines. On behalf of my associates as well as myself, I would like to express publicly our heartfelt appreciation of the wonderful hospitality, the warm friendliness and the fine cooperation we have received from our Filipino associates. We are grateful also for the interest and support of ICA officials Dr. Renne, Ray Johnson, Mr. Summers, Dr. W. F. Dickson and their associates.

It is particularly appropriate that Cornell should be engaged in this cooperative project because of the close friendly relationship between the University and the Philippines that began when President Jacob Gould Schurman came here as chairman of the Philippine Commission nearly sixty years ago. These ties have been

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[1] General Contribution No. 883. Read before the Manila Rotary Club on February 13, 1958.

[2] Dean, New York State College of Agriculture, Cornell University.

strengthened over the years by the students who have come to study at Cornell. We are very proud of our many distinguished alumni here in the Islands and of the splendid records they have made in industry, in agriculture and in public service.

I should admit at the outset that I am a firm supporter of the technical cooperation programs with other free countries in which the United States is now engaged. While mistakes are made occasionally, as in all human affairs, in my opinion, they are a sound and constructive method of helping others to help themselves. During my professional experience of four decades I have seen the progress in agriculture and other fields in my own country made possible by research and education. I believe that a sound program which has worked in the United States can be made to work well here.

Since 1920, the U.S. population has increased from 106 to 173 millions or 63 per cent while the total acreage of crop land harvested has remained steady at 340 to 350 million acres a year. During this same period, the total output of food and fiber has increased about 70 per cent while the proportion of the population engaged in agriculture has declined from 10 to 12 per cent. In other words, American farmers have produced *more and better food per person from the same acreage for our growing population and at the same time they have more than doubled the output per worker.*

This great increase in farm production and efficiency is due largely to mechanization, specialization and the application of science to agriculture. The most publicized factor is farm power machinery which enables one man to do more work. Increased yields per acre and per animal have been equally important if less spectacular factors in increasing farm productivity. Some land formerly required to produce feed for work animals has been released for food production, but at least three-fourths of the increased output is the result of scientific research applied on farms since 1920.

These achievements have been made by American farmers under a system of free choice competitive enterprise with the aid of machinery, fuels, feeds, fertilizers, pesticides and credit provided by private business firms. They have been made possible by careful painstaking scientific research by hundreds of scientists in agricultural experiment stations and private research laboratories.

Agricultural colleges are generally considered to be farm institutions to serve farmers. Actually they serve the welfare of consumers even more. The first farmers to use a better variety of a crop

or an improved method of production do benefit from it temporarily because it gives them a competitive advantage over other producers. However, as soon as other farmers adopt the improved practice it results in greater output and a lower price. Since farming is highly competitive the savings through improved methods of production and marketing are shared with consumers through lower prices or better quality or both.

The Agricultural Extension Service and the teaching of students share with the Experiment Stations in the credit for these achievements. Research has developed better varieties of crops and improved methods of production and marketing. Resident instruction has trained men and women for skilled positions in many lines of agricultural work. The Extension service has greatly shortened the time lag between the discovery of improved methods and their use on farm. New higher yielding varieties of crops or improved methods of production are put into prompt use by effective teamwork between research and extension. Extension has also kept research closely geared to important practical farm problems.

The fact that each American farmer is feeding 2½ times as many persons as in 1920 means a better living in peace and a better chance for survival in war, either cold or hot. The planes and missiles for war as well as the automobiles, refrigerators and television sets for peace, can be produced only by workers not required to produce food and fiber.

These changes in agriculture are only one example of the use of research and education which, under a free choice competitive system, has given the American people a high and rising standard of living. Food production is basic but comparable advances have been made in every other essential industry.

The only way in which any nation can achieve a higher standard of living is by increasing the output per worker throughout the economy, on farms, in factories and in other business both private and public. The best way to increase the output per worker is by the vigorous and intelligent application of research and education to the problems of production and marketing in agriculture and in industry. Research is not a quick easy cure-all for all economic ills. It is slow, unspectacular and involves hard work by trained scientists. But it gets results.

According to newspaper reports, the Philippines is faced with a substantial shortage of rice, due in part to a severe drought. In such

an emergency, many suggestions are offered each of which is claimed to be a solution of the basic problem of inadequate food production. Emergency actions will undoubtedly be necessary to make up for the deficit by imports and to stimulate increased production during the next few years. *However, these emergency measures will not solve the long run problem of inadequate home production of food.*

In the long run, the surest way to achieve self-sufficiency in food production and to provide a sound agricultural base for a dynamic economy is by a vigorous, consistent and intelligent program of agricultural research, resident teaching and extension. Good ideas on the use of irrigation, better seeds, mechanization, fertilizers and pesticides can be obtained from other countries but it is impossible and unprofitable to imitate such practices exactly in the Philippines because of differences in social, economic, soil and climatic conditions. To be sound and practical, such practices must first be modified and *adapted* to your conditions.

The Philippines, like every other country, must start where it is and make progress from there. Hence, the real job is to improve present Philippine methods in the most effective and economical way. This requires careful research by trained agricultural scientists to find out the important factors limiting production and the best way to increase yields under Philippine conditions. The next step is to arrange demonstration plots on different soils to learn how these practices apply under varying local conditions. The final step is to provide enough trained Extension agents to teach farmers in the barrios how to use better practices that will be profitable on their farms. This process takes time, it requires hard work by trained people, and it costs money but there is no short cut to sustained agricultural progress.

Substantial progress has been made in the last five years by your U.P. College of Agriculture although much remains to be done. The buildings and equipment which were destroyed during the war have been replaced and enlarged to meet the needs of the enlarged student body. Los Baños has reestablished its position as one of the leading agricultural colleges of Southeast Asia and is attracting students from nearby countries in increasing numbers. The student enrollment has increased to the capacity of the present staff and about 300 students will graduate this year. This is probably the minimum number to meet the needs of the country for trained work-

ers in agricultural teaching, research and in business related to agriculture.

The Central Experiment Station was established at Los Baños in 1918 but it received no regular financial support until 1952; and even now its resources are entirely inadequate for the important work to be done. Improved varieties of rice and of hybrid corn have been developed by the Plant Breeders and better ones will follow. These new varieties will give much higher yields under Philippine conditions and Seed stocks are now being increased for use by farmers in a few years. An artificial insemination center has been established to increase the progeny of selected sires in improving cattle and hogs. Research studies are being made to find out how to use fertilizers profitably on different soils under varying local conditions. Other studies are in progress to find out how much water is needed for irrigation under different conditions and when it should be applied for best results. Entomologists and Plant Pathologists are finding effective economical methods of pest control and so on. Continued progress in increasing food production depends on *finding and correcting the most important factor limiting yields at a given time.* The job is not simple but it can be done and it pays generous returns on the investment.

The excellent reputation for agricultural research and public service that is being earned by the U.P. College of Agriculture has resulted in a marked increase in grants for research and teaching by private corporations, government agencies and international agencies such as Rockefeller Foundation. While such grants are very desirable to expand important lines of work *they do not reduce the need for adequate dependable support by the National Government.* Modest increases in salaries have been made but further improvement is necessary in order to retain a high quality staff. *If the Philippine government is serious in its desire to achieve food self-sufficiently it must provide a substantial increase in financial support for agricultural research and education on a dependable continuing basis.* The funds required for such a program are an investment in national welfare that will pay high returns.

A well planned, adequate and consistent program of agricultural research will make possible a steady increase in agricultural productivity in the Philippines. However, the success achieved in increasing output will depend in part on other factors. The best results can be expected with a free choice competitive economy in

which farmers are free to decide what to grow, and how to grow it and get the rewards of their efforts. The tenure system must provide adequate incentives to tenants by giving them a fair share of the increased output. Credit must be made available to farmers on a business basis so they can buy improved seeds, fertilizers and pesticides necessary for higher yields. And private business firms must provide the materials and services required by modern agriculture at a fair competitive price.

While health and adequate food are basic requirements of any nation, development along many lines is essential to sound national progress. The Philippines, like the U.S., needs more and better elementary schools, high schools and colleges to promote better citizenship, increased productivity throughout the economy and better living for all citizens. While lack of capital is a limiting factor in Philippine development, the *most serious* shortage, here and everywhere, is *trained people,* scientists, engineers and in other essential professions. Industry and commerce should be expanded to provide a wide variety of goods and services for all, and to exert continuing pressure on farmers for greater labor efficiency. Good roads and adequate transportation at reasonable cost are essential to provide the widest possible exchange of goods and services within the national boundaries.

Modern medical science has made an enormous contribution to human welfare by reducing sickness and lengthening life. It has also increased the severity of population pressures because of the rapid increase in numbers resulting from lower infant mortality. The best that the United States has been able to do over a series of years is to increase the national output of goods and services about 3 per cent a year. Since population has been rising at a lower rate, less than 2 per cent a year, we have been able to earn a modest increase in output per person, a rising standard of living. The present rate of population increase in this country is a challenge to national leaders and to every citizen. *A very high rate of increasing output must be achieved and sustained if the citizens of the next generation are to enjoy a higher standard of living than you have today.*

The basic job of American scientists and teachers in technical cooperation at Los Baños is to make themselves unnecessary as soon as possible by helping to train local scientists for effective work. We, at Cornell, expect that our present project in agriculture will

end at the conclusion of our present contract in June, 1960. By September, 1958, fifty-four young promising instructors will have returned to the Philippines after completing a year of postgraduate training in the United States. If they are given adequate financial support, these younger men and women under the leadership of Dean Uichanco will have an opportunity to help develop a strong agricultural base for your expanding economy.

We have sent only our ablest Professors to Los Baños and we are proud of the work they have done in cooperation with their Filipino friends and associates. It has not been easy to spare these men for the College at Cornell is responsible for giving continuing service of high quality to the farmers and consumers of New York State who provide our financial support. However, we have been amply rewarded for our efforts. Every Professor we have sent here has returned to Cornell a better trained, broader, more competent scientist and teacher because of the experience he has had working under different conditions with broader responsibilities. And the friendships we have made will, we hope, help to bind our two nations more closely together in defense of freedom now and in the years to come.

CHEMICAL COMPOSITION OF SOME GRASSES AND LEGUMES FROM DIFFERENT AREAS IN THE PHILIPPINES [1]

J. K. Loosli,[2] K. C. Beeson, N. C. Brady [2] and E. Farinas

Chemical analyses are reported for eighteen forage species, collected at five widely separated areas in the Philippines. Proximate analyses are in agreement with earlier reports for these forages. None of the forages were deficient in cobalt but white flint corn was deficient. Three samples appeared marginal in copper content but none was markedly deficient. X-ray spectrographic analyses showed that none of the forages contained more than 3-4 ppm of molybdenum. Values for total sulfur are also reported.

Limited data on the chemical composition of livestock feeds in the Philippines have been reported.[3,4,5] Only proximate analyses were made, except by the latter workers [4] who also reported data on calcium and phosphorus. The occurrence of unthriftiness and anemia in cattle and the loss of pigmentation in the hair of young carabaos at the Central Experiment Station directed attention to possible deficiencies of the trace elements, cobalt and copper, in livestock feeds. Preliminary tests at the Central Experiment Station, however, did not show evident responses of cattle to cobalt and copper supplements.

Samples of forages were collected on four widely separated stock farms of the Bureau of Animal Industry and at the Central Experiment Station farms. As far as possible the same plant species was collected at each location, and an attempt was made to obtain the samples at similar stages of maturity. These objectives were not fully achieved. Collection and transport of the fresh plants was carefully handled to avoid possible contamination with soil or other materials. The samples were dried under heat lamps at the

[1] Central Experiment Station Contribution No. 1962.

[2] Former Cornell visiting professors in the U.P. College of Agriculture.

[3] F. T. Adriano, *Philippine Agriculturist*, **18**, 199 (1929).

[4] D. Y. Odejar and L. R. Masankay-Arenas, Philippine Jour. Anim. Indus., **12**, 29 (1951); **10**, 371 (1949).

[5] L. A. Ynalvez, L. Austria, E. Cruz and J. K. Loosli, *Philippine Agriculturist*, **37**, 587 (1954).

Central Experiment Station. The mineral element analyses were made at the U.S. Nutrition Laboratory and the proximate analyses in the Animal Nutrition Division, Department of Animal Husbandry, Cornell University, Ithaca, N.Y.

The data obtained are summarized in table 1. The proximate analyses show reasonably good agreement with values reported earlier in the Philippines for the same plant species.

It is of special interest that no forage sampled was deficient in cobalt, based on data from Australia and the U.S.A. which show that symptoms of cobalt deficiency do not occur in ruminants when the forage contains 0.07 ppm or more (dry basis) of cobalt. Thus, no evidence was found that cobalt might be a factor limiting cattle production with the forages sampled.

Most of the values for copper appear adequate to meet the needs of livestock, although some samples (Bukidnon grass, cogon grass, and natal grass) were marginal in copper content. It is known that a high molybdenum content of grasses increases the need for copper. The sulfate content of rations also influences the utilization of copper. Molybdenum could not be detected in these forages by the x-ray spectrograph. Hence, it was not in excess of 3 to 4 ppm which is below the toxic range. The sulfur content was relatively high in most samples (table 1). Only three contained as little as 0.06 per cent sulfur, and a deficiency of this element seems unlikely.

The sample of white flint corn grain analyzed was low in cobalt in line with data from the U.S.A. where corn grain has been found to be uniformly low in cobalt content.

One of the samples of cogon grass, Bukidnon grass, culape, and an unidentified grass species were very low in phosphorus content. All other samples were adequate to meet the requirements of mature cattle. Several samples were too low for young growing cattle, however, if the grass was the only feed available. The use of phosphorus fertilizer is known to increase the yields of cultivated crops in certain areas, but fertilizer trials have not yet been applied to forage crops in the various areas of the Philippines. Preliminary results from the Bongabon and Muntinglupa areas show marked yield increases in cultivated crops from the use of phosphate fertilizers. It is likely that the phosphorus content of the fertilized forages would be higher than that from unfertilized areas.

TABLE 1.—*Proximate and mineral element composition*

SAMPLE	DRY MATTER	PROTEIN	ETHER EXTRACT	CRUDE FIBER	N-FREE EXTRACT	ASH	CALCIUM	PHOS-PHORUS	COBALT	COPPER	SULFUR
	%	%	%	%	%	%	%	%	%	*ppm*	*ppm*
Alabang × (*Andropogon nodosus* [Willem] Nash.) 1.[a]	91.8	5.8	1.8	36.1	36.4	11.7	0.38	0.25	0.10	7.9	.23
" " " 2.	92.4	6.4	0.9	37.0	35.4	12.7	0.29	0.16	0.10	4.6	—[b]
" " " 2.	92.7	4.8	1.6	35.9	41.0	9.4	0.28	0.20	0.08	3.7	.06
" " " 4.	90.3	9.9	1.4	32.2	38.5	8.3	0.28	0.27	0.09	8.1	.25
Alfalfa, before bloom 5.	93.0	21.7	3.6	23.8	35.1	8.8	1.18	0.31	0.25	9.0	.33
" " " 2.	91.8	21.4	3.1	22.9	35.9	8.5	0.94	0.29	0.19	9.2	—[b]
Bagocboc lalake 4.	91.1	6.2	0.8	30.6	41.5	12.0	0.51	0.13	0.10	4.6	.07
Bermuda grass	90.8	10.7	0.8	27.6	40.8	10.9	0.50	0.21	1.80	23.3	.45
Bukidnon grass	90.4	3.5	0.8	35.5	41.8	8.8	0.21	0.12	0.15	2.9	.07
Bungalon (*Echinochloa stagnina* Beauv.)	92.8	5.7	1.0	30.5	46.6	9.0	0.36	0.27	0.89	15.6	.31
Centrosema pubescens Benth.	91.9	17.0	1.7	39.7	28.5	5.0	0.79	0.19	0.26	17.9	—[b]
Cogon (*Imperata cylindrica* [Linn.] Beauv.)	92.3	6.8	1.9	36.7	38.9	8.0	0.51	0.25	0.54	7.3	—[b]
" " " 1.	93.0	3.8	1.2	36.7	54.9	6.4	0.36	0.10	0.12	3.3	.05
" " " 2.	92.7	7.4	1.6	35.8	40.4	7.5	0.20	0.22	0.16	4.8	—[b]
" " " 3.	92.2	8.3	1.3	36.3	38.9	7.4	0.21	0.14	0.10	6.0	.11
" " " 4.	91.4	7.6	1.0	33.8	41.6	7.4	0.24	0.15	0.13	5.2	.11
Calopogonium mucunoides Desv.	91.7	12.3	2.8	42.5	26.0	7.1	1.39	0.20	0.55	12.1	.23
Culapé (*Paspalum conjugatum* Berg.)	89.6	7.3	0.8	25.9	45.4	10.2	0.33	0.20	1.55	11.0	.08
Guinea grass (*Panicum maximum* Jacq.)	91.0	7.4	1.1	33.2	37.9	11.4	1.09	0.18	0.24	8.7	.21
Misamis grass (*Andropogon micranthus* Kunth.) 1.	92.9	8.2	1.9	28.3	47.7	6.8	0.23	0.15	0.13	6.5	.06
Molasses grass	89.6	5.6	1.2	31.5	42.8	8.5	0.13	0.24	0.92	7.9	.14

[a] The forages were obtained from the Central Experiment Station, College, Laguna unless otherwise noted, as follows: 1. Boñgabon Stock Farm, Nueva Ecija, Luzon; 2. Dumarao Stock Farm, Dumarao, Capiz; 3. La Carlota Stock Farm, La Carlota, Negros Occidental; 4. Milagros Stock Farm, Milagros, Masbate; and 5. Canlubang Sugar Central, Laguna.

[b] Not determined because of insufficient sample.

TABLE 1 (continued)

SAMPLE	DRY MATTER	PROTEIN	ETHER EXTRACT	CRUDE FIBER	N-FREE EXTRACT	ASH	CALCIUM	PHOS-PHORUS	COBALT	COPPER	SULFUR
	%	%	%	%	%	%	%	%	%	*ppm*	*ppm*
Natal grass (*Rhynchelytrum roseum* [Ness] Stapf and Hubb)	93.7	3.8	1.3	40.9	42.0	5.7	0.32	0.14	0.22	3.3	— [b]
Para grass (*Panicum purpurascens* Raddi)	91.5	7.7	1.3	35.0	38.2	9.3	0.26	0.22	0.27	12.1	.32
" " " " 2.	91.3	10.1	2.2	29.5	40.4	9.1	0.22	0.32	0.74	9.0	.23
" " " " 3.	91.7	11.8	1.4	29.0	39.9	13.6	0.32	0.25	0.19	13.3	.31
" " " " 3.	92.6	11.6	1.8	28.9	39.8	14.5	0.35	0.25	0.23	14.6	.29
" " " " 4.	93.0	6.5	1.0	34.2	42.1	9.2	0.18	0.28	0.09	11.0	.21
" " " " 4.	92.9	6.6	1.8	33.2	42.2	9.3	0.17	0.30	0.08	7.9	.19
Culapé (*Paspalum conjugatum* Berg.)	92.7	5.3	0.9	32.5	44.0	10.0	0.49	0.11	0.38	5.2	.30
Tropical kudzu (Pueraria javanica Benth.)	90.8	13.8	1.7	46.1	20.6	8.6	0.81	0.23	0.74	17.9	.33
" " " " 1.	92.7	17.8	1.3	26.6	40.0	7.0	1.19	0.15	0.25	8.1	.22
" " " " 1.	92.2	13.5	0.7	38.2	33.7	6.1	0.91	0.23	0.17	12.9	— [b]
" " " " 2.	91.2	17.4	2.3	33.2	32.4	5.9	0.68	0.28	0.16	11.5	.23
" " " " 3.	92.2	18.1	0.6	31.6	35.5	6.4	0.77	0.21	0.33	12.5	.23
" " " " 4.	91.7	15.6	1.2	34.1	34.0	6.8	0.92	0.16	0.13	9.8	.16
Silibon grass	92.9	5.2	1.2	31.7	55.4	9.4	0.35	0.16	0.16	3.7	.05
Mixed pasture grass	91.6	7.8	1.3	29.3	42.3	10.9	0.35	0.14	0.16	5.2	.08
Unidentified grass	90.3	6.3	0.5	34.5	37.2	11.8	0.33	0.10	0.38	6.0	.16
" "	92.2	5.7	1.0	30.5	46.6	9.0	—	—	—	—	— [b]
White Flint corn grain	90.4	10.9	4.5	2.8	71.3	0.9	0.004	0.26	0.03	2.9	.16
Approx. requirement for growth	—	—	—	—	—	—	0.30	0.25	0.07	4.5	—

In general the analyses presented show that the cobalt or copper content of most of the forage grasses sampled were high enough that supplements of these mineral elements would not be expected to be highly beneficial to older cattle or other ruminant animals. Sampling of other areas and additional forage species, and the extension of the chemical analyses to include still other mineral elements would be desirable. Certain samples were marginal in copper content in terms of requirements for optimum growth of young animals. It seems that under some conditions special mineral supplements supplying calcium and phosphorus may be advantageous for optimum growth of young cattle, but for many of the forages a shortage of protein and energy would appear to be more common.

* * *

This Fifth Estate is composed of those having the simplicity to wonder, the ability to question, the power to generalize, the capacity to apply. It is in short, the company of thinkers, workers, expounders, and practitioners upon which the world is absolutely dependent for the preservation and advancement of that organized knowledge which we call Science.... The world needs most a new tolerance, a new understanding, an appreciation of the knowledge now at hand. For these it can look nowhere with such confidence as to the members of the Fifth Estate. Let us, therefore, recognize the obligation we are under. Ours is the duty and the privilege of bringing home to every man the wonders, the significance, and the underlying harmony of the world in which we live.

—*Arthur Dehan Little*

CHEMICAL ANALYSES OF CADANG-CADANG-INFECTED COCONUTS, SUPPOSEDLY HEALTHY PALMS FROM THE CADANG-CADANG AREA AND HEALTHY TREES FROM THE COLLEGE OF AGRICULTURE WHERE THE DISEASE DOES NOT OCCUR [1]

L. A. Ynalvez, R. R. Covar, and G. O. Ocfemia [2]

Cadang-cadang-infected coconut palms, supposedly healthy palms from the cadang-cadang area and healthy trees from the College of Agriculture at Los Baños where the disease does not occur were analyzed to see whether or not differences in amounts of some of the major and minor elements may be correlated with the disease.

MATERIALS AND METHODS

The samples used in the chemical analyses were part of the specimens collected for examination with the electron microscope. The specimens consisted of opened leaves, unopened leaves, cabbage, and unopened spathes of diseased and supposedly healthy coconut palms. The specimens were collected from the Cadang-cadang Research Station of the Bureau of Plant Industry, Guinobatan, Albay, on December 27-29, 1956 by G. O. Ocfemia and A. D. Bustrillos, Electron Microscopist of the Central Experiment Station with the cooperation of Avelino E. Bigornia, Entomologist, and Carlos A. Calica, Plant Pathologist of the Cadang-cadang Research Station. Mr. Bigornia and Mr. Carlos Calica who have had much experience in telling apart the different kinds of yellowing helped in collecting the materials and care was taken to exclude specimens from coconuts with yellowing caused by poor soil, wet feet and other factors. For purposes of comparison of the state of health of the supposedly healthy coconut palms from the Cadang-cadang Station samples taken from opened leaves of 24 coconut palms from the College of Agriculture and environs where cadang-cadang does not occur were analyzed.

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[1] Central Experiment Station Contribution No. 1963. Read by the senior author before the Two Hundred and Fifty-third regular scientific meeting of the Los Baños Biological Club held on October 25, 1957.

[2] Senior Analyst, Spectrographer, and Emeritus Professor of Plant Pathology, respectively, of the College of Agriculture and Central Experiment Station.

From these specimens Ocfemia and Bustrillos (1957)[3] reported that they had noted numerous uniform particulate bodies of nearly spherical shape along with the plant debris present in the unpurified juices of cadang-cadang-infected coconuts. With these particulate bodies the authors believe that they have secured an evidence that cadang-cadang is caused by virus.

Determinations were made for (a) sodium, (b) potassium, (c) calcium, (d) magnesium, (e) manganese, (f) iron, (g) phosphorus, (h) boron, and (i) copper.

The Model DU Beckman Quartz Flame Spectrophotometer, equipped with oxyhydrogen burner and a phototube multiplier was used for the determination of sodium, potassium, calcium, magnesium, and manganese. The Coleman Universal Spectrophotometer Model 14 was used for the colorimetric determination of iron, phosphorus, boron, and copper. The alpha alpha dypiridyl method was used for iron, the molybdenum blue method for phosphorus, the diethyldithiocarbamate method for copper and the quinalizarin method for boron. The colorimetric methods used are the official methods adopted by the Association of Official Agricultural Chemists. All reagents used were C.P. and A.C.S. chemicals. The distilled water used was triple-distilled in a boro-silicate all glass distilling apparatus and stored in a 4-liter boro-silicate glass stoppered bottle. All glasswares used were of Pyrex glass. They were rinsed with concentrated nitric acid, then with triple-distilled water before use.

The samples for analysis were dried in an infra-red oven purposely designed to minimize contaminations of the samples. From the moisture-free material, exactly 200 milligrams were weighed for analysis. The method adopted for weighing samples was tedious, but it was advantageous in that instrumental indications gave at once a picture of the results.

For ashing, the nitric-perchloric acid method was adopted. Samples were digested in a fume hood specially designed to prevent metal contamination of the samples being digested. The samples were digested until colorless but they were not allowed to get dry. To the digested samples about 25 ml. distilled water was added, then boiled to remove silica, washed, and the volume made up to 50 ml. Portions were taken for flame photometric analysis for the elements being

[3] G. O. Ocfemia and A. D. Bustrillos, *Philippine Agriculturist*, **40**, 553 (1957).

determined. Then aliquots of 2 ml. were taken for colorimetric analysis for phosphorus and 5 ml. of each for iron, boron, and copper.

RESULTS AND DISCUSSION

The results of the analyses are shown in table 1.

TABLE 1.—*Analysis of healthy and cadang-cadang–infected coconut palms* (Milligrams per 100 grams of moisture-free sample)

METAL	UNOPENED LEAVES		OPENED LEAVES		INFLORESCENCE		CABBAGE		OPENED LEAVES
	Healthy [a]	Diseased	Healthy [a]	Diseased	Healthy [a]	Diseased	Healthy [a]	Diseased	Healthy [b]
	mg.	*mg.*	*mg.*	*mg.*	*mg.*	*mg.*	*mg.*	*mg.*	*mg.*
B	0.20	0.23	0.21	0.20	0.19	0.20	0.21	0.21	0.20
Cu	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Fe	2.18	1.75	2.56	0.13	2.00	2.77	2.24	1.63	2.10
Mn	0.65	0.65	0.65	0.65	0.58	0.73	0.73	0.73	0.83
Ca	5.90	8.30	11.00	8.30	11.00	13.80	10.00	11.00	15.00
Mg	9.50	7.30	8.80	7.30	10.30	11.80	15.30	10.30	11.00
P	9.88	11.88	10.33	14.13	8.50	18.18	33.05	22.00	9.05
K	8.75	11.30	8.80	10.30	5.80	10.80	11.00	13.80	9.80
Na	1.10	1.40	1.80	1.30	1.06	2.50	1.80	1.50	3.20

[a] Healthy coconuts from the Cadang-cadang Research Station in Banao, Guinobatan and Parian, Camalig, Albay.

[b] Healthy coconuts from the College of Agriculture and neighborhood.

The results indicated that the phosphorus in the opened leaves of the diseased palm from Guinobatan was higher than that in the healthy coconut from the College. Except in the inflorescence, the iron in the diseased palms was lower than that in the healthy plant; and, in the opened leaves iron was very small compared with that in the College healthy specimens. In view of these differences one might infer that iron was deficient in the soil. The apparent low absorption of iron, however, might be the effect of the suboxide of iron present in the soil. Iron is an important constituent both of the cytochrome system and of the protoplasm. The higher phosphorus and potassium content in the diseased coconut palms might be attributed to the disease. Infection with cadang-cadang might be responsible for the lower content of magnesium (except in cabbage), calcium, potassium (except in cabbage), and sodium in the diseased and in the apparently healthy specimens from Guinobatan as compared with the samples from healthy trees from the College of Agriculture. The deficiencies and excesses in the plants might

have made them favorable for the multiplication and spread of the virus.

No differences in copper content were noted in the cadang-cadang-infected and normal coconuts. Copper shortage is characterized by a permanent wilting of the upper leaves.[4] In cadang-cadang, however, the young leaves are dwarfed and brittle, and they remain green until shortly before the tree dies. The writers noted little difference in boron contents between the healthy and diseased coconuts.

From the result of chemical analysis it appeared that the iron content of the opened leaves might indicate some relation to the health of the palm. However, literature does not report that virus diseases are responsible for iron deficiency in the tissues of infected plants. Neither are there cases reported in which deficiency of iron has made virus disease more severe. The opened leaves from the supposedly healthy palms from Guinobatan had higher iron content than the opened leaves from the College. The iron of the infected coconut was much lower than in the supposedly healthy specimen from Guinobatan and that from the College of Agriculture.

SUMMARY

1. The iron content of the unopened leaves, inflorescence and cabbage of cadang-cadang infected coconut palms is lower than that of the healthy palms. It is very low in the opened leaves.

2. The phosphorus and potassium content in the opened leaves of the diseased palms are slightly higher than those in the healthy coconuts from the College of Agriculture.

3. There is no difference in the copper content of the cadang-cadang-infected and normal coconuts. There is little difference in the boron content of the healthy and diseased coconuts.

[4] J. E. McMurtrey, Jr., and W. O. Robinson, *U. S. Department of Agriculture Yearbook*, **1939**, 807-829 (1939).

DAIRY QUALITIES OF PHILIPPINE COWS

VALENTE VILLEGAS and EPIFANIA C. CRUZ [1]

The average milk yield of mature Philippine cows was 189,879.7 milliliters per lactation, the lowest yield being 1,967 milliliters and the highest 828,317 milliliters. The mean daily milk yield was 660.0 ± 307.858 milliliters. The highest average daily milk yield was 2,263.2 milliliters and the lowest, 56.2 milliliters. The highest milk yield in one day was 4,000 milliliters, the lowest, 118 milliliters.

The mean lactation period of mature cows was 144.4 ± 13.252 days, the shortest being 35 days and the longest, 366 days. The three young cows had an average lactation period of 140.3 days, the longest being 230 days and the shortest, 67 days.

The mean specific gravity of the milk of Philippine cows was 1.03 ± 0.002, the range being from 1.0224 to 1.0409.

The mean moisture percentage of the milk was 85.37 ± 1.017, that of protein 5.77 ± 0.402, butterfat 4.56 ± 0.713, lactose 5.91 ∓ 0.689, and minerals 0.96 ± 0.054.

The yield of cottage cheese had an average of 256.1 grams per liter of milk.

On the average 52.34 grams of butter were obtained from one liter of milk.

Villegas and Peña [2] found that the average yield of milk of Philippine cows was 259.5 liters by the native system of management and only 17.5 liters by the approved system of dairy management. The period of lactation was 188 days by the native system, and 126 days by the approved system. The fat test of milk in both cases was 3.9 per cent.

In the native system of dairy management the calves were separated at night and allowed to stay with their dams in the daytime, and the milk for human consumption was obtained in the morning. At about seven months of age, the calves were completely separated from their dams, and from this time up to the end of the lactation period the cows were milked morning and afternoon. In the approved system, the calves were separated from their dams

[1] Central Experiment Station Contribution No. 1964. The authors acknowledge the help of Messrs. Exequiel de los Reyes and Jacinto L. Gallardo in carrying out the work.

[2] Valente Villegas and Daniel B. Peña, *Philippine Agriculturist*, **14**, 609 (1926).

a few days after birth and thereafter the sows were milked morning and afternoon until the end of lactation.

This work was carried out in the Department of Animal Husbandry from May 27, 1955, to April 16, 1957.

Seven Philippine cows were placed in a barn provided with wooden stanchions, concrete mangers and flooring. The calves were separated three to nine days after freshening. The cows were fed in the barn twice a day with soilage consisting principally of Para grass and *Centrosema pubescens* Benth. Soilage was freely supplied and concentrates were given in amounts that were readily taken by the animals. The concentrate mixture consisted of ground corn, fine rice bran and copra meal in equal parts by weight. Lime and salt in equal parts were added to the concentrate at one per cent of the mixture. Watering was done twice daily. The cows were milked morning and afternoon. Eighteen milk samples for proximate analysis were taken at random from cows Nos. 2, 13, 26, 40 and 42.

DISCUSSION OF RESULTS

Milk yield

Table 1 shows that the milk yield of mature cows averaged 189,879.7 milliliters per lactation, the lowest yield being that of cow 26 which gave only 1,967 milliliters and the highest, that of cow 13 which yielded 828,317 milliliters. The second lactation of cow 13 gave only 562,330 milliliters. Cow 31 gave 4,777 milliliters at the first lactation and 35,167 milliliters at the second lactation. Cow 34 was also a high yielder with 70,299 milliliters.

The mean daily milk yield was 660.0 $\pm$ 307.858 milliliters, just about three glassfuls. The average daily milk yields of 2,263.2 and 1,808.1 milliliters in two separate lactations of cow 13 were noteworthy. The lowest average daily yield of 56.2 milliliters was obtained from cow 26.

The highest daily milk yield was obtained from cow 13 which gave 4,000 milliliters on her second lactation. The least was that of cow 26 which gave 118 milliliters. The mean of the highest daily yields from all the cows was 1,855.1 $\pm$ 434.252 milliliters.

Three young cows (Nos. 40, 41, and 42) with an average age of three years, 5 months, 11 days, gave an average of 143,583.3 milliliters of milk. Cow 42, the highest producer of the three, gave

391,831 milliliters; cow 40, the lowest producer, gave only 17,587 milliliters.

Lactation

Table 1 shows that the mean lactation period of five mature cows in eight lactations was 144.4 ± 13.3 days. The shortest period was that of cow 26 which was 35 days, and the longest was 366 days, the first lactation of cow 13.

The three young cows (Nos. 40, 41 and 42) had an average lactation period of 140.3 days. Cow 42 gave the longest lactation period of 230 days and cow 40, the shortest lactation period of 67 days.

Specific gravity and chemical analysis of milk

Table 2 shows the specific gravity and chemical analysis of milk.

The mean specific gravity was 1.03 ± 0.002, the range being from 1.0224 to 1.0409.

The mean moisture content of the milk was 85.37 ± 1.017 per cent, the lowest being 76.06 per cent and the highest, 89.77 per cent. The mean protein content was 5.77 ± 0.402 per cent, the range being from 0.14 to 5.86 per cent. The mean butterfat test was 4.56 ± 0.713 per cent ,the minimum amount being 1.2 per cent and the maximum, 12.10 per cent. The mean lactose content was 5.91 ± 0.689 per cent, the range being from 0.58 to 12.38 per cent. Minerals had a mean of 0.96 ± 0.054 per cent. The minimum amount was 0.60 per cent and the maximum, 1.64 per cent.

Cottage cheese

Two samples of fresh milk were curdled with rennet extract and prepared for the production of cottage cheese. The yield was from 241 to 271.2 grams per liter of milk, or an average of 256.1 grams.

Butter

An average of 52.34 grams of butter of light yellow color was obtained from one liter of milk.

TABLE 1.—*Milk yield and lactation period of mature Philippine cows*

COW NO.	AGE AT FRESHENING	MILK YIELD	LACTATION PERIOD	AVERAGE DAILY MILK YIELD	HIGHEST YIELD IN ONE DAY
		ml.	*days*	*ml.*	*ml.*
13	About 11 years	828,317	366	2,263.2	2,993
13	" 12 "	562,330	311	1,808.2	4,000
14	" 12 "	7,013	55	127.5	1,475
14	" 13 "	9,168	70	131.0	1,725
26	6 years, 11 months	1,967	35	56.2	118
31	5 years, 4 days	4,777	44	108.6	722
31	5 years, 10 months, 28 days	35,167	144	244.2	2,218
34	5 years, 4 months, 1 day	70,299	130	540.8	1,590
Mean		189,879.7	144.4 ± 13.252	660.4 ± 307.858	1,855.1 ± 434.252

TABLE 2.—*Chemical analysis of milk of Philippine cows*

ITEM	SPECIFIC GRAVITY	MOISTURE	PROTEIN	BUTTERFAT	LACTOSE	MINERALS
Mean	1.030 ± 0.002	85.37 ± 1.02	5.7 ± 0.4	4.56 ± 0.71	5.91 ± 0.69	0.96 ± 0.05
Range	1.0224–1.0409	76.06–89.77	0.14–5.86	1.20–12.10	0.58–12.38	0.60–1.64

THE EFFECT OF "TM-5" (TERRAMYCIN FEED SUPPLEMENT) UPON THE RATE OF GROWTH OF GROWING AND FATTENING PIGS [1]

J. A. Eusebio and R. B. Puyaoan [2]

As a feed supplement in a ration with 16 to 17 per cent protein, terramycin at 0.91 kilogram per 100 kilograms mash increased the rate of gain in weight during the early stage of the pig (17.84 to 30.43 kilograms). However, the increase in the growth rate for the whole period was not significant. There was a wide variability in response of the pigs to the antibiotic supplement. In some cases, there was a trend towards a sudden reduction in weight gains after removing the supplement from the ration.

It was more economical to feed rations with antibiotic supplement. It required 4.03 kilograms feed with terramycin supplement to gain a kilogram pork. Terramycin in the ration for growing weanlings reduced pig scours and hence, mortality.

The addition of antibiotic feed supplements to rations for growing and finishing swine is becoming common practice in the Philippines. Since there is meagre factual information on the advisability of using these supplements in the production of market pigs, this study was conducted at the Swine Division, College of Agriculture, U.P. from June, 1956 to January, 1957.

Bowland *et al.* (1951), Carpenter (1950), and Edwards *et al.* (1950) have reported that the feeding of antibiotics to pigs results in improved rates of gain. On the other hand, Mensalvas and Sugon (1956) claimed that rations supplemented by one-half kilogram Aurofac to every 100 kilograms of the mash did not significantly improve the rate of growth of growing and fattening pigs, although Aurofac-fed pigs had glossier and smoother skin and finer hair. However, there are indications that antibiotic supplements in the ration will reduce the level of dietary protein required for pigs to attain a standard rate of gain. Cunha (1950) found that when aureomycin supplement was added to corn-peanut meal ration, the

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[1] Central Experiment Station Contribution No. 1965. Research project No. 901.

[2] Acknowledgment is due Cornell Visiting Professor Robert Spalding and Dr. Valente Villegas for their helpful suggestions.

protein content could be reduced by 10 per cent without decreasing the rate of growth. Similar findings were obtained by Catron *et al.* (1952) for rations containing aureomycin and by Hoefer *et al.* (1952) for rations containing 5 mg. of terramycin per pound of feed.

MATERIALS AND METHODS

Fourteen Berkjala-Berkshire crossbred weanling pigs (eight barrows and six females) were grouped at random into two lots according to weight, age, and sex. Seven apparently healthy and vigorous 2-month-old pigs were assigned in each lot.

Lot I, designated as the control, was fed twice a day, once in the morning and once in the afternoon, with the College standard rations Nos. 2, 3 and 4 having the following formula:

INGREDIENT	RATION		
	2	3	4
Ground corn	15	20	25
Fine rice bran	60	60	60
Copra meal	18	16	13
Fish meal	3.5	2.0	1.0
Soybean oil meal	5.25	3.0	1.5
Mineral mixture [a]	1.5%	1.0%	1.0%
Protein (%)	17	16	15

[a] Composed of equal parts by weight of common table salt and ground shells.

Soybean oil meal was used to replace one-half fish meal because in a previous study [3] it did not lower the protein requirements of the rations for growing pigs.

Lot II, the experimental lot, was fed the same ration supplemented with 0.91 kilograms of TM-5 (terramycin feed supplement) to every 100 kilograms of concentrate feed.

The pigs in both lots had three 8-week feeding periods each. Ration No. 2 was fed during the first period, No. 3 during the second, and No. 4 during the third.

The animals in both lots had two separate pens with adjoining pastures; soilage was provided daily whenever pasture was not avail-

[3] R. B. Puyaoan. "Further study on the effect of soybean oil meal in rations for growing and fattening pigs." Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, 1957. (Unpublished).

able. Abundant water for drinking was provided in troughs for each group. The initial body weight of each pig was taken as the average of three daily weights at the start of the experiment. The final weight was taken in the same manner at the end of the feeding period. In addition, weekly weights were taken until the 24th week to show the trend of the rate of gain in weight (fig. 1). The difference between the initial and final weights was used as the criterion for determining the feeding value of terramycin supplement on the growth response of the pigs. The data obtained were subjected to statistical analysis.

RESULTS AND DISCUSSION

Growth response. The group of growing and fattening pigs fed with the antibiotic feed supplement had 9.21 kilograms average gain in weight and the non-antibiotic-supplemented group made 6.17 kilograms during the first feeding period. Jensen *et al.* (1952, 1955) reported that in the early stage of the pigs, terramycin-fed pigs with 36-75 lbs. liveweight (16.36-34.09 kilograms) gained significantly faster than non-supplemented pigs at all protein levels.

The terramycin-fed group made 39.85 kilograms average gain in weight and the non-supplemented group, 34.30 kilograms for the whole growing period. However, the terramycin-fed group did not show a significant difference in growth rate. The average daily gain in weight of the experimental lot was greater in the first period when the animals were fed the ration with 17 per cent protein than in the second with 16 per cent protein or the third with 15 per cent protein (table 1). There was a wide variability in response of pigs to the antibiotic supplements but there were some indications of an increased daily gain with increasing protein requirements when antibiotic was added to the ration. These findings corroborate those of Jensen *et al.* (1952) and Hironaka and Cowland (1954).

The difference in average weight gains between the experimental and the control lots was not significant; however, greater uniformity of growth was evident in the supplemented group (table 2). These results agree with the findings of Mash and Dunkin (1956).

To test further the effect of TM-5 feed supplement on the growth of pigs, the study was prolonged for three more weeks with the antibiotic deleted in the ration. In some cases, there was a sudden reduction in rate of weight gains after terramycin supplement was removed from the ration. Burnside *et al.* (1953) and Hiro-

TABLE 1.—*Summary of results*

	FIRST 8-WEEK PERIOD		SECOND 8-WEEK PERIOD		THIRD 8-WEEK PERIOD		ENTIRE 24-WEEK PERIOD	
	Lot I [a]	Lot II [b]	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II
Number of animal	7	7	7	7	7	7	7	7
Average initial weight, kg.	9.97	8.66	16.14	17.87	28.13	30.43	9.97	8.66
Average final weight, kg.	16.14	17.87	28.13	30.43	44.27	48.51	44.27	48.51
Average gain in weight, kg.	6.17	9.21	11.99	12.56	16.14	18.08	34.30	39.85
Average daily gain is weight, kg.	0.11	0.16	0.21	0.22	0.29	0.32	0.20	0.24
Average feed consumption, kg.	28.49	27.74	56.54	53.31	81.57	79.57	166.60	160.62
Average daily feed consumption, kg.	0.51	0.50	1.01	0.95	1.46	1.42	0.99	0.96
Average amount of feed per kilogram gain in weight, kg.	4.62	3.01	4.72	4.24	5.05	4.40	4.86	4.03
Cost of feed per per kilogram gain in weight, pesos [c]	0.88	0.63	0.90	0.89	0.96	0.92	0.92	0.85

[a] Control lot.
[b] Experimental lot.
[c] Cost of feed, lot I, ₱0.19; lot II, ₱0.21.

TABLE 2.—*Average gain in weight after the 24-week period*

LOT	ANIMALS							TOTAL
	1	*2*	*3*	*4*	*5*	*6*	*7*	
I	36.8	31.0	31.0	34.3	38.6	26.4	42.0	240.1
II	34.7	39.5	31.8	39.0	44.7	43.1	40.2	273.0
Total	71.5	70.5	62.8	73.3	83.3	69.5	82.2	513.1

Analysis of variance

SV	DF	SS	MS	F-VALUE
Lots	1	77.32	77.32	3.47 [a]
Animals within lots	13	289.54	22.27	
Total	14	366.86		

[a] Not significant.

naka and Bowland reported that removal of the antibiotic from the ration during the middle or latter part of the feeding period caused a concomitant decrease in rate of gain.

Feed consumption and feed cost. The average amount of feed to gain a kilogram weight was 4.86 kilograms in the non-antibiotic supplemented group and 4.03 kilograms in the supplemented group. It cost only ₱0.85 to produce a kilogram gain in weight with terramycin feed supplementation and ₱0.92 without addition of antibiotic. In spite of the insignificant difference in gain in weight of the two lots, it was more economical to feed rations with antibiotic supplement.

Dressing percentage. The average dressing percentages of two pigs from each lot which were slaughtered at the Meat Processing Laboratory of the College were 74.6 per cent for the experimental and 73.1 per cent for the control. Villegas and Mondoñedo (1938) found that Berkjala pigs, on the average, give an average dressing percentage of 73.2 per cent.

Effects of terramycin supplement on carcass quality were not marked, but slightly longer and leaner sides were noted for lot II than for lot I. Catron *et al.* (1952) observed no significant difference between antibiotic and non-antibiotic treatments in back fat depth, length and depth of body or percentage of lean in the carcass of lard-type hogs.

Other observations. There were apparently no indications of pneumonia in the lungs of the two treated animals slaughtered.[4] Terramycin appeared to exert a preventive influence on the incidence of scours during the early weanling stage while these animals were confined in concrete pens, which predispose animals to pneumonic conditions and which prevented the animals from getting soil nutrients. Iron, which is abundant in soil, was also found to aid in controlling the filth-born virus of pig diarrhea.

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BIOLOGICAL STUDY OF *LYMANTRIA LUNATA* CRAMER, (LYMANTRIIDAE, LEPIDOPTERA), WITH A CONSIDERATION OF ITS CONTROL [1]

EMILIANA S. NOVERO

WITH TEN TEXT FIGURES

Lymantria lunata Cramer feeds on the leaves of citrus and other host plants and may cause complete defoliation, especially if the trees attacked are still small. Infestation is severe during the months of December and January.

The incubation period ranges from 8 to 10 days for the female and 7 to 10 days for the male; larval period, 44 to 51 days for the female and 38 to 43 days for the male; pupal period, 8 to 11 days for the female and 9 to 12 days for the male; egg-laying to emergence, 53 to 60 days for the female and 48 to 54 days for the male.

The larva passes through six instars. The first molt usually occurs 6 days after hatching in both male and female; the second molt, 5 days after the first molt in both sexes; the third molt, 4 days after the second; the fourth molt, 4 days after the third; the fifth molt, 7 days (in the female) and 6 days (in the male) after the fourth; and the sixth molt, 12 days (in the female) and 9 days (in the male) after the fifth molt. The eggs are laid in irregular masses on the leaves, in one to three ovipositions.

Two larval-pupal parasites, *Brachymeria* sp. and a tachinid fly were found. DDT spray (0.1 and 0.2 per cent) was found effective in killing the larvae. Dieldrin of the same concentration was almost as effective.

Lymantria lunata Cramer is an injurious pest which attacks orchard trees. Caterpillars of this species feed on citrus leaves leaving only the midribs and sometimes causing complete defoliation, especially if the trees attacked are still small. Garden crops, like eggplant and pepper, as well as forest or lumber trees, are known to be attacked also.

To control the pest, a study of its life history is very important, but no study has yet been made on this species in the Philippines or elsewhere. Reports have been made on the related species *Lyman-*

[1]Central Experiment Station Contribution No. 1966. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1956. Prepared in the Department of Entomology under the direction of Dr. Silverio M. Cendaña.

tria monacha L., *Porthetria dispar* L., and others of the family Lymantriidae, doing great damage, not only on field and garden plants, but also on orchard and lumber trees. Curran [2] pointed out that more than 500 species of the family Lymantriidae are known, the most injurious belonging to genus *Lymantria.* Fiske [3] reported on the early invasion of fields, gardens and orchards by lymantriidae caterpillars, and suggested methods of controlling them.

The present work was conducted in the entomology laboratory of the College of Agriculture, from November, 1954, to December, 1955, to study (a) the life history of the pest, (b) its host plants, (c) natural enemies, and (d) possible methods of control.

MATERIALS AND METHODS

Larvae of *Lymantria lunata* Cramer collected from the field and reared to adulthood in wire breeding cages were allowed to mate and lay eggs.

The newly-hatched larvae were isolated individually in cotton-plugged vials and supplied daily with fresh pieces of citrus leaves to feed on. Each larva was given a culture number and the ecdyses were observed at each daily inspection of the culture. When the larvae reached the fourth instar, they were transferred individually to larger bottles covered with coarse-meshed cloth to give them more space for development. The larvae were allowed to pupate individually in the bottles. The adults which emerged from the individual cultures were confined in pairs (♂ and ♀), in breeding wire cages and provided with citrus leaves to oviposit on.

Fresh specimens and preserved materials of the various stages of the insect were studied. The features of the egg and pupa were observed on fresh specimens. Anatomical studies of the different larval instars, as well as of the adult, were made from balsam-mounted stained specimens, which had been cleared in 5 per cent KOH. These studies were supplemented by observations from fresh specimens as well as from alcohol-preserved materials, which were first fixed in hot water at about 75° to 80° C for about 5 minutes. A compound microscope and a binocular were used in examining the details. Measurements were taken with an eye-piece micrometer

[2] C. H. Curran, "Insects of the Pacific World," McMillan Company, New York, 1946, 317 pp.

[3] W. F. Fiske, "Review of Applied Entomology, 1, 33 (1913).

and a footruler (cm. scale) for big materials; whenever possible, a camera lucida was used in drawing.

The host plants were determined by direct observation of infested materials in the field. In the laboratory, leaves of different orchard trees were given to the larvae in the same amount to determine which of the feeds the larvae preferred.

Regular monthly observations were made in the field to determine the abundance and relative monthly infestation of the trees.

Eggs, larvae and pupae were collected in the field. These were confined in the laboratory for whatever parasites they would subsequently yield. The parasites that emerged were preserved for identification.

Control measures. Lead arsenate (0.05 per cent), Dieldrin (0.1 per cent) and DDT (0.2 per cent) sprays were tried for their efficiency in controlling *Lymantria lunata.* Two methods of application with three trials each were tried. In the first, the plants with ten caterpillars already feeding on them were sprayed; in the second method, the plants were first sprayed before allowing the caterpillars to feed on them. The number of living, moribund, and dead larvae were counted at regular intervals after spraying.

RESULTS AND DISCUSSION

Life history and habits

The female moths laid from 86 to 874 eggs with an average of 399.23 eggs each (table 1). Of these, 98.41 per cent hatched.

The eggs in a given mass hatched at the same time. Hatching took place at any time of the day. The larva cut an irregular opening at the free end of the egg and forced itself out through it.

The newly hatched caterpillar suspends itself with a silk thread to look for food. While young, the larvae consume only the fleshy portion of the upper leaf surface, leaving the nether surface to dry to a papery membrane, but as they reach the third instar they eat up the whole leaf, leaving only the veins and the midrib. In all instars, the larvae do not feed for as long as 7 to 12 hours prior to ecdysis.

It took four to six hours to harden the body parts of the freshly molted larva before it resumed feeding. Instances were noted when the head capsule was removed ahead of the body skin or the skin

TABLE 1.—*Number of eggs laid by Lymantria lunata moths and percentage of hatch*

FEMALE NO.	TOTAL NO. LAID	NUMBER HATCHED	PERCENTAGE HATCHED	FEMALE NO.	TOTAL NO. LAID	NUMBER HATCHED	PERCENTAGE HATCHED
1	438	430	98.17	29	786	786	100
2	516	501	97.09	30	275	275	100
3	170	170	100	31	388	370	95.10
4	107	102	95.32	32	437	437	100
5	558	530	94.96	33	281	263	93.48
6	705	705	100	34	394	394	100
7	292	292	100	35	446	446	100
8	308	308	100	36	406	400	98.52
9	426	426	100	37	339	330	97.34
10	344	340	98.83	38	496	496	100
11	187	187	100	39	801	801	100
12	546	546	100	40	783	779	99.48
13	354	352	100	41	127	120	94.48
14	781	776	99.35	42	286	277	96.85
15	325	321	98.22	43	394	390	98.98
16	296	296	100	44	331	331	100
17	573	570	99.47	45	408	400	98.03
18	703	700	99.58	46	129	129	100
19	136	136	100	47	334	334	100
20	497	497	100	48	209	205	98.08
21	338	330	97.63	49	551	550	99.81
22	874	871	99.65	50	86	86	100
23	687	687	100	51	98	98	100
24	436	420	96.33	52	503	500	99.40
25	283	283	100	53	236	236	100
26	474	474	100	54	288	278	96.52
27	387	387	100	55	192	192	100
28	183	170	92.89				
Average					399.23	392.90	98.41

removed ahead of the head capsule. The larvae were fed day and night in the laboratory.

A day or two before pupation, the full-grown larva ceased to feed and remained stationary. In the 1918 experiment of Loeb[4] with the lymantriid *Porthetria dispar,* the caterpillars were photopositive until they finished feeding and reached maturity; they then became photonegative and descended the food plant to pupate in the

[4] *Cited in* C. H. Curran, "Insects of the Pacific World," MacMillan Company, New York, 1946, 317 pp.

soil at the base. Brundt [5] (1937) observed that *Lymantria monacha* larvae were positively phototactic and negatively geotactic until maturity and the completion of feeding, then tended to settle in fairly shaded places where pupation took place. Similarly, the caterpillars of *Lymantria lunata* were observed to migrate to larger branches during the day. They were hardly noticeable because of their similarity to the color and conformation of the bark.

Mating takes place within one to two days after emergence of the female, usually at night although copulation may also occur during daytime. A female moth may lay 86 to 874 eggs, all of which may be laid during one oviposition, although usually, two or three ovipositions take place. While laying eggs the female stands squarely on its legs, extends its slightly bent abdomen downward, sways from side to side, and sometimes moves slowly forward as the eggs are laid. It takes one to one and a half minutes for the female to lay an egg. Egg masses are irregular in shape, laid in one to four layers. Together with the eggs are exuded grayish hair-like fibrous secretions, possibly from the colleterial glands, that cover the egg masses. An egg mass contains 47 to 203 eggs.

Female moths are docile and, unless disturbed, they stay in place where they alight, unlike the males which move continuously around.

Length of life cycle. Table 2 shows the duration of the different stages of *Lymantria lunata,* based on a study of 100 males and 100 females. The incubation period of eggs that developed into female moths ranged from 8 to 10 days, with a mean of 8.58 $\pm$ 0.08 days; that of the males, 7 to 10 days, with a mean of 8.22 $\pm$ 0.06 days. Most of the eggs hatched 8 days after they were laid.

The larva passes through six instars. The first stadium ranged from 5 to 8 days, with a mean of 6.34 $\pm$ 0.07 for the females, and 6 to 8 days for the males with a mean of 6.40 $\pm$ 0.05 days. The first molt occurred usually 6 days after hatching.

The second stadium ranged from 4 to 7 days with a mean of 4.66 $\pm$ 0.17 days for females, and 3 to 6 days with a mean of 5.64 $\pm$ 1.10 days for the males. The second molt usually took place 5 days after the first molt in both sexes.

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[5] *Cited in* C. H. Curran, "Insects of the Pacific World," MacMillan Company, New York, 1946, 317 pp.

TABLE 2.—*Duration of the different stages of Lymantria lunata*

DEVELOPMENTAL PERIOD	FEMALES (100 individuals)			MALES (100 individuals)		
	Range (days)	Usual (days)	Mean [a] (days)	Range (days)	Usual (days)	Mean [a] (days)
Incubation	8–10	8	8.58 ± .08	7–10	8	8.22 ± .06
First stadium	5– 8	6	6.34 ± .07	6– 8	6	6.40 ± .05
Second stadium	4– 7	5	4.66 ± .17	3– 6	5	5.64 ± .10
Third stadium	3– 7	4	4.58 ± .04	3– 6	4	4.48 ± .09
Fourth stadium	3– 6	4	4.40 ± .09	3– 6	4	4.36 ± .06
Fifth stadium	4– 8	7	6.58 ± .09	4– 8	6	5.64 ± .07
Total larval period	11–14	12	12.44 ± .10	5–10	9	7.34 ± .18
Sixth stadium	44–51	49	47.66 ± .21	38–43	42	40.92 ± .14
Pupal period	8–11	9	9.24 ± .08	9–12	11	10.52 ± .09
Egg laying to emergence	53–60	56	56.90 ± .18	48–54	51	51.38 ± .15

The third stadium ranged from 3 to 7 days with a mean of 4.58 ± 0.04 days for females and 3 to 6 days with a mean of 4.48 ± 0.09 days for males, the third molt usually occurring 4 days after the second in both sexes.

The fourth stadium ranged from 3 to 6 days with a mean of 4.40 ± 0.09 days for females, 3 to 6 days making an average of 4.36 ± 0.06 days for males, the fourth molt usually occurring 4 days after the third molt for both sexes.

The range of the fifth stadium was 4 to 8 days, with an average of 6.58 ± 0.09 days for females; 4 to 8 days with an average of 5.64 ± 0.07 days for males. Molting usually occurred 7 days after the fourth molt in the males and 6 days in the females.

The sixth stadium ranged from 11 to 14 days with an average of 12.44 ± 0.10 days for the females and from 5 to 10 days with a mean of 7.34 ± 0.18 days for the males. Pupation usually took place 12 days after the fifth molt in the females and 9 days in the males.

The larval development (egg-hatching to pupation) has a range of 44 to 51 days, with a mean of 47.66 ± 0.21 for females, pupation usually occurring 49 days after hatching. For the males, pupation took place within 38 to 43 days after hatching and the larval development, 40.92 ± 0.14 days, usually 42 days. The duration of the pupal stage was from 8 to 11 days with a mean of 9.24 ± 0.08 for the females, the adult usually emerging 9 days after pupation; for the males, pupal period varied from 9 to 12 days with a mean of

10.52 ± 0.09 days, the adult usually emerging 11 days after pupation.

The total developmental period (egg-laying to emergence of adult moth) ranged from 53 to 60 days with a mean of 56.90 ± 0.18 days, usually 56 days for the females, and from 48 to 54 days, usually 51 days for the males.

From November, 1954, to December, 1955, six generations of *Lymantria lunata* were reared.

The egg. Subglobular, slightly flattened underneath, about 0.9 mm. in diameter, pale pinkish when newly laid, turning gray a few hours later and almost grayish black before hatching. Covered sparsely with hairy filaments (fig. 1).

Larval instars. First-instar larva (fig. 2) brownish white when newly hatched, turning greenish after it has fed. Dorsally, head dark brown, thorax and abdomen lighter; abdominal segments light brown dorsally, with long setae (about four times as much as width of body) on lateral area, and short dorsal setae (abut as much as width of body); fifth and last segments almost white. Prolegs on third to sixth and ninth abdominal segments only. Prolegs taper apically to almost a point, expanding subsequently distally, terminated by numerous crochets, six of which are about twice as large as the others. Length of average, newly hatched larva 3.40 to 3.80 mm.; width 0.50 to 0.65 mm.; head capsule 0.65 mm. long and 0.68 mm. wide.

Second-instar larva brownish white, with same dorsal markings on abdomen as in first-instar larva but darker. Ventral side light brown. Length of body 11.90 to 12.25 mm.; width 1.55 to 1.65 mm.; head case about 1.10 to 1.20 mm. long and 1.10 to 1.15 mm. wide.

Third-instar larva brown, mottled with darker brown irregular spots. Dorsal area of abdomen, where short tufts of setae arise, remain dark brown, except the fifth and last segment, as in the first-instar larva. Length 15.55 to 19.00 mm. and 1.65 to 2.00 mm. wide; head capsule about 1.85 mm. in length and 1.80 mm. in width.

Fourth-instar larva has similar dorsal abdominal markings as the third instar larva, but a brown transverse band becomes evident on the first thoracic segment; ventral area of thorax and abdomen light brown with greenish-black line running longitudinally at the middle. Length 22.45 to 24.15 mm.; width 3.40 to 3.65 mm.; head capsule 3.10 mm. long and 3.05 mm. wide.

Fig. 1.—Freehand drawing of egg of *Lymantria lunata* Cramer (×40).

Fig. 2.—Freehand drawing of chaetotaxy of newly-hatched larva (×20).

Fifth-instar larva similar to fourth-instar in color markings. Green median line at ventral area darker and wider than in fourth instar. Length 41.50 to 50.00 mm.; width 8.40 to 9.00 mm. Head measures about 4.15 mm. in length and 4.10 mm. in width.

Body fairly thickly beset with long setae which are borne on large tubercles, there being three rows of setae tubercles (dorsal, lateral, and subventral) on each side in the thoracic segments, and in five rows (dorsal, subdorsal, epispiracular, anterior subventral, and posterior subventral) in the abdomen.

Sixth-instar larva is similar to third-, fourth-, and fifth-instar larvae, except that it is much larger. General color brown, body slightly tapering posteriorly, characterized by the following markings: head brown, fairly mottled with dark brown spots at adfrontal area of epicranium; front brownish white, antennae and mouth parts brown. Ventral area of thorax and abdomen very light brown with a greenish black line running longitudinally at mid-ventral region, which is lighter and narrower at thorax, becoming wider and darker posteriorly. Lateral and dorsal areas of body light brown mottled with darker brown spots all over. Thoracic legs brownish red. Abdominal legs light reddish orange at base, lighter-colored apically with a characteristic white sub-apical area; distal end of proleg slightly sinuate, light brownish red.

Head subglobular, five-sixth as long as wide. Setal arrangement, as in figure 3. Antennae three-segmented, tapering distally; segment 1 sub-annular, length about one-fourth the total length of antennae, about 3 times as wide as long; segments II and III one-third as wide as I; III about twice as long as II, bearing short stout bristles and a long slender one at the distal end. Labium sub-rectangular, about three times as long as wide; labial palpus two-segmented; segment I, about one and one-half times as long as broad and three-fourths the length of the whole palpus; segment II, one-fourth the length of the whole palpus, about as long as broad and bearing a bristle about one-half the whole length of the palpus at the apex. Mandibles dark, about one-fourth as long as head capsule, bi-dentatus. Maxillae beset with long setae; maxillary palpus three-segmented; segment I, about two-fifths the total length of the palpus and one-half times as long as broad; segment II, about as long as broad and one-half times as long as segment 1, with short, stout, and long slender bristles at base; segment III, about one-fourth the total length of the palpus, about one and one-half times as long as broad. Labrum deeply cleft about two-thirds as long as wide; clypeus sub-rectangular, about twice as broad as long, front V-shaped; genae with long slender setae.

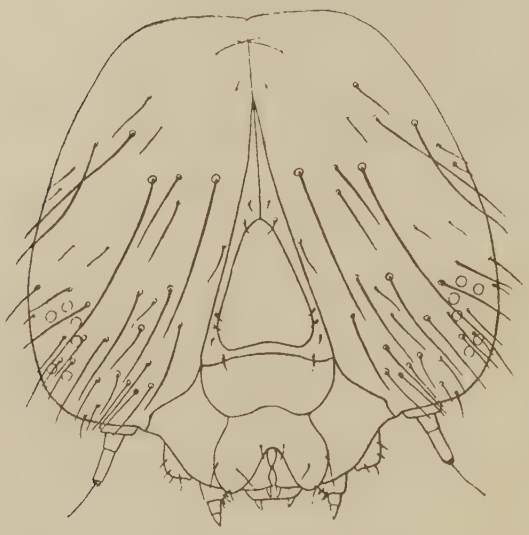

Fig. 3.—Freehand drawing of head of sixth-instar larva, anterior aspect (×10).

Body fairly thickly beset with long and short setae that are borne on large tubercles. The setal arrangement on the first thoracic segment is shown in figure 4, and that of the first abdominal segment is shown in figure 5. Long setae about one-fourth as long as total body length; short bristle-like setae borne dorsally on first to eleventh body segment, about one-sixth the length of the long setae; medium length setae K and π groups borne laterally from second to eleventh segment, about one-half the length of longer setae.

An average-sized full-grown larva measured 60.40 mm. in length, 10.00 mm. in width, and 8.20 mm. in thickness; head capsule about 4.90 mm. in length and 4.80 mm. in width.

The pupa. Elongate-oval, about three times as long as thick, thickest at thorax, rounded anteriorly but tapering gradually to a pointed abdomen, last abdominal segment terminated with fibers by which pupa is attached to the host. Dorsal area of abdomen characterized by two pairs of groups of white hairs on segments VII and VIII, a pair of groups of pinkish brown hairs on the ninth, and 2 pairs on the last segment. General color, pale brunneus immediately after pupation, changing to dark brunneus prior to emergence of adult (fig. 6).

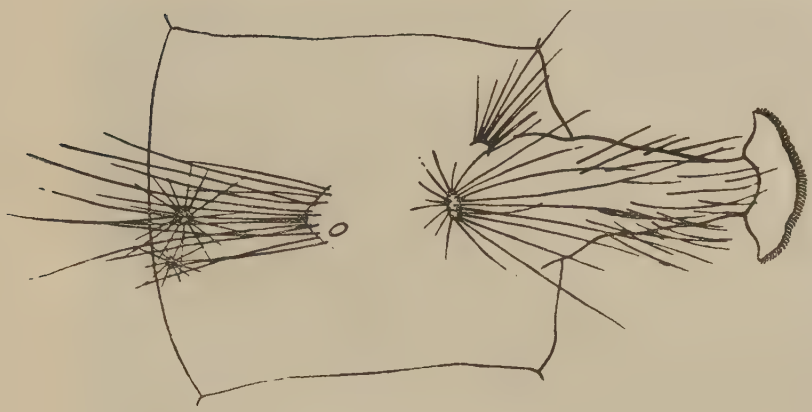

Fig. 5.—Freehand drawing of setal arrangement of first abdominal segment, sixth-instar larva (×6).

Fig. 4.—Freehand drawing of setal arrangement of first thoracic segment, sixth-instar larva (×5).

Fig. 6.—Freehand drawing of pupa of male, lateral aspect (×2).

Adult male. General color ash-gray, very much mottled with black. Head slightly darker than thorax. Eyes grayish-black, subspherical, each eye about 1.90 mm. in diameter. Abdomen pinkish-brown with black mid-dorsal line and inter-segmental heads; ventral area of abdomen grayish black (fig. 7a).

Thorax subcylindrical, about one-third the total length of body. Fore wing about twice as long as bread; ashy gray above, very much mottled with black spots, the most conspicuous of which being one at middle of wing and 8 along the margin; dirty whitish gray below. Hind wing straw-colored above with pinkish tinge, shading to ash

gray apically with six small submarginal dark spots; dirty down below.

Fig. 7.—Adult moths (×1). (a) male; (b) female. (*Photograph taken by the Photographic Division.*)

Foreleg about three-fourths the total length of body. Coxa subconical, one-half as broad as long; about one-sixth the length of leg, trochanter subrectangular, length about twice as wide; femur widest at basal 2/5, about one and two-fifths times as long and two-thirds as wide as coxa; tibia subcylindrical, about as long and two-thirds as broad as femur, with a large, entobasal spur which is about six-seventh as long and as wide as tibia; tarsus about as long as tibia, five-segmented; segment I about one-fourth as long and three-fourths as wide as tibia; other segments slightly shorter and narrower than the more proximal; claws stout, sharply pointed, arcuate ventrally.

Mesothoracic leg slightly longer than foreleg. Coxa subtriangular, twice as wide as long and two-thirds as long as femur; trochanter subconical, twice as long as wide, one-fifth as long as femur; femur subfusiform, one-sixth as wide as long about one-third of total length of leg. Tibia subcylindrical, tapering slightly basally, as long and three-fourths as wide as femur, with two entodistal dagger-shaped spurs, one of which being about two-thirds the size of the other; bigger spur about one-fifth as long and one-third as wide as tibia; tarsus as long as tibia, five-segmented, each segment

subcylindrical; segment I about one-half as long and two-thirds as wide as tibia; segment II, slightly narrower and about one-third as long as I; segment III, about two-thirds as long as II, slightly narrower; segment IV, about one-half as long as II, slightly narrower; last segment, as broad and as long as II; claws as in foreleg.

Fig. 8.—Adult female moth with egg mass (×1.5).
(*Photograph taken by the Photographic Division.*)

Metathoracic leg slightly longer than mesothoracic leg; coxa subtriangular, twice as wide as long, about two-thirds as long as femur; trochanter subcylindrical, one-third as long and one-fifth as wide as coxa; femur subfusiform about two-seventh the total length of leg; widest at middle and tapering slightly at both ends; tibia subcylindrical widest at middle and tapering distally, about as long and two-thirds as broad as femur, with a pair of distal and a pair of subdistal spurs; tarsus about one and one-third as long and two-thirds as broad as tibia; II and V, subequal and about one-third as

long as I; III and IV, subequal and two-thirds as long as II; claws as in mesothoracic leg. Venation of fore and hind wings are shown in figures 9a and 9b.

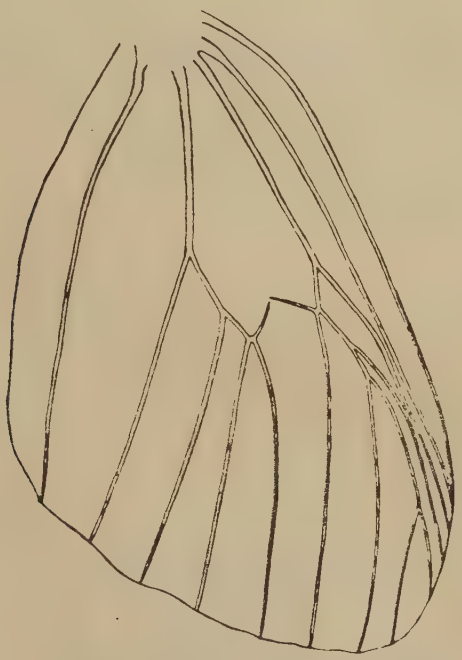

Fig. 9a.—Camera lucida drawing of fore wing of male moth (×3.5).

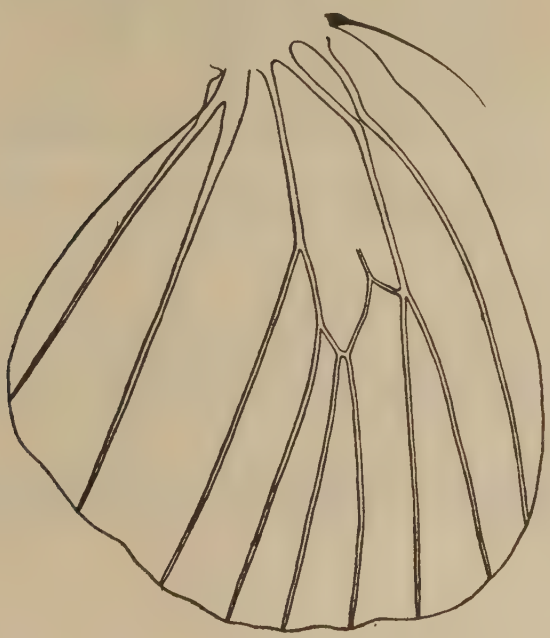

Fig. 9b.—Camera lucida drawing of hind wing of male moth (×3.5).

Abdomen pinkish brown dorsally with a dark median and intersegmental bands; gray ventrally with 7 visible segments; widest at segment II tapering posteriorly. Male genitalia is shown in figure 10.

Fig. 10.—Freehand drawing of male genitalia, lateral aspect (×25).

Length (from tip of head to tip of abdomen) of adult male 20.5 to 22.65 mm.; wing expanse, 40.2 to 50.1 mm. An average-sized moth measured 21.30 mm. in length; wing expanse, 45.1 mm.

Adult female. General color pinkish white with dark bands on wings. (fig. 7).

Head suboval from anterior aspect, 3.00 mm. in length, about as wide as long, covered with light pink scales, eyes grayish black;

antennae reaching to about one-third to one-half the body length when bent, composed of 52 to 56 segments. Thorax pinkish white above and below.

Fore wing about twice as long as broad, general color very light pink with the following gray markings: 7 inconspicuous, submarginal, somewhat crescent-shaped dark spots, a narrow line across at the outer 5/6 of length of wing, a broad dark band at the middle of the wing, parallel to the preceding, and an irregular sub-basal dark line. Hind wing about two-thirds as long and five-sixths as wide as forewing, very light pink, anal area with darker pink hairs; uniformly very light pink below.

Foreleg about equal in size as meso- and meta-thoracic legs, coxa subconical; width about two-thirds as wide as long; trochanter subcylindrical, about one-fifth the length of coxa; femur widest at middle, about one-fourth the total length of leg, tibia subcylindrical, about as long as femur, one-fourth as wide; tarsus five-segmented; segment I about one-half as long and two-thirds as broad as tibia; segments II and V subequal, about one-half as long as I; segments III and IV subequal, shorter than II, claws arcuate with arolium between them. Except for darker tibiae, the legs are concolorous with body.

Mesothoracic legs about same appearance as prothoracic legs, except that tibia has one pair of dagger-shaped entodistal spurs, which are about one-eighth as long as tibia.

Metathoracic leg is of same size and appearance as mesothoracic leg, except that in addition to the pair of dagger-shaped entodistal spurs, there is also a pair of subdistal spurs, which are of about the same size as the distal pair.

Adult female is from 23.00 to 34.40 mm. from tip of the head to tip of abdomen and from 80.10 to 90.25 mm. in wing expanse. Average-sized moth measured 31.1 mm. in length and 85.0 in wing expanse.

Table 3 shows the longevity of male and female moths under laboratory conditions. Female moths may live for as long as 14 days after emergence, usually 9 to 11 days. Male moths may live for as long as 9 days after emergence, usually 6 to 8 days.

Seasonal occurrence. In the course of the experiment, abundance of the caterpillars in the fields was observed from the later

TABLE 3.—*Longevity (emergence to death) of Lymantria lunata moths*

LONGEVITY (days)	FEMALE	MALE
1	0	0
2	0	1
3	0	2
4	1	5
5	2	6
6	2	10
7	5	25
8	8	18
9	17	3
10	9	0
11	22	0
12	1	0
13	2	0
14	1	0
Mean	9.46	6.62

part of October to the early part of March. The greatest infestation was observed in December and January.

Host plants. In the field, the caterpillars were observed to attack different species of citrus (Citrus spp.), eggplant (*Solanum melongena* Linn.), pepper (*Capsicum annum* Linn.), santol (*Sandoricum koetjape* [Burm. f.] Merr.), guava (*Psidium guajava* Linn.), siniguelas (*Spondias purpurea* L.), hog plum (*Spondias lutea* Linn.), tamarind (*Tamarindus indica* Linn.), papaya (*Carica papaya* Linn.), balsa tree (*Ochroma lagopus* Siv.), aguho (*Casuarina equisetifolia* Forst), bamboo (*Bambusa blumeana* Schultes F.) pomegranate (*Punica granatum* Linn.), duhat (*Eugenia jambolana* Lam.), cashew (*Anacardium occidentale* Linn.), and balimbing (*Averrhoa carambola* Linn.).

Natural enemies. Two larval-pupal parasites,[6] *Brachymeria* sp. and a tachinid fly were reared for identification from the specimens that were collected from the field. The attacked larvae either died before pupation, or if they were able to pupate, were not able to emerge.

Control measures. Table 4a shows the relative effectiveness of Dieldrin, DDT, and Lead arsenate in killing the larvae on infested

[6] The natural enemies are deposited with the Department of Entomology, College of Agriculture.

citrus plants. At 0.05 per cent concentration, the three insecticides were about equally effective in killing the larvae. Most of of the larvae became moribund within 48 hours after spraying, but total kill of the larvae was not attained until about 144 hours after treatment. At 0.1 per cent concentration, DDT showed stronger killing effect than either Dieldrin or Lead arsenate. It gave a complete kill of larvae after 96 hours; Dieldrin and Lead arsenate, after 120 hours. But at 0.2 per cent concentration each of the insecticides killed the larvae after 96 hours. Dieldrin followed DDT in effectiveness; the least effective was Lead arsenate. All the larvae in the control remained alive at the end of the experiment.

Table 4b shows the relative effectiveness of Dieldrin, DDT, and Lead arsenate when applied as sprays on citrus plants before the larvae were allowed to attack them. At 0.05 per cent concentration, complete kill of the larvae by the three insecticides tested was obtained after 144 hours as in method I. But all the larvae on plants sprayed with 0.1 per cent DDT and Dieldrin were killed after 120 hours. Each of the three insecticides killed all the larvae after 120 hours when applied at 0.2 per cent concentration. In the control, all the larvae remained alive and normally pupated subsequently.

TABLE 4a.—*After-treatment larval counts for the different insecticides with larvae on plants at the time of spraying (average of 3 trials)*

INSECTICIDE	CONCENTRATION	HOURS AFTER TREATMENT																	
		8			24			48			72			96			120		
		L	M	D	L	M	D	L	M	D	L	M	D	L	M	D	L	M	D
Dieldrin		8.7	1.3	—	6.0	2.7	1.3	3.7	3.0	3.3	1.5	2.7	6.0	0.3	1.0	8.7	—	—	10
DDT	0.05%	8.7	1.3	—	6.3	2.3	1.3	3.7	2.7	3.0	1.3	1.7	7.0	0.3	1.0	8.7	—	—	10
Lead arsenate		8.7	1.3	—	7.4	2.3	0.3	5.3	1.7	3.0	2.3	2.4	5.3	—	1.3	—	—	—	10
Dieldrin		7.7	2.0	0.3	6.0	1.7	2.3	3.0	2.0	5.0	1.0	2.3	7.0	—	0.3	9.7	—	—	10
DDT	0.1%	8.7	1.3	—	4.7	2.3	3.0	1.6	1.0	7.3	—	.3	9.7	—	—	10	—	—	—
Lead arsenate		8.0	2.0	—	6.3	2.7	1.0	4.0	2.7	3.3	1.3	2.0	6.7	—	0.3	9.7	—	—	10
Dieldrin		1.3	2.3	0.3	4.7	2.3	3.0	2.3	1.3	6.3	.3	.3	9.4	—	—	10	—	—	—
DDT	0.2%	8.7	1.3	—	6.0	2.3	2.7	1.7	3.0	5.3	—	.3	9.7	—	—	10	—	—	—
Lead arsenate		8.0	1.7	—	6.0	2.3	1.7	2.3	2.3	5.4	1.3	.3	6.4	—	—	10	—	—	—
Control		10	—	—	10	—	—	10	—	—	10	—	—	10	—	—	10	—	—

[a] L—living; M—moribund; D—dead.

TABLE 4b.—*After-treatment larval counts for the different insecticides with larvae introduced to the plants after spraying (average of 3 trials)*

INSECTICIDE	CONCENTRATION	HOURS AFTER TREATMENT																			
		8			24			48			72			96			120			144		
		L	M	D[a]	L	M	D	L	M	D	L	M	D	L	M	D	L	M	D	L	M	D
Dieldrin		9.7	0.3	—	8.3	1.4	0.3	5.3	2.0	2.7	2.7	1.6	5.7	1.0	1.7	7.3	—	1.0	9.0	—	—	10
DDT	0.05%	9.0	1.0	—	7.0	2.3	0.7	4.0	2.3	3.7	1.7	2.0	6.3	1.0	1.3	7.7	—	0.3	9.7	—	—	10
Lead arsenate		9.0	1.0	—	7.7	2.3	—	5.3	2.3	2.4	3.7	1.0	4.3	2.0	1.7	6.3	0.7	1.0	8.3	—	—	10
Dieldrin		8.3	1.7	—	5.7	2.7	1.6	2.7	2.7	4.6	1.0	1.0	8.0	—	.7	9.3	—	—	10	—	—	—
DDT	0.1%	9.0	1.0	—	7.0	1.3	1.7	3.0	3.3	3.7	1.0	1.7	7.3	—	.3	9.7	—	—	10	—	—	—
Lead arsenate		8.3	1.7	—	6.7	3.3	—	4.0	3.7	2.3	2.0	2.0	6.0	1.0	1.7	7.3	—	0.7	9.3	—	—	10
Dieldrin		9.3	.7	—	6.7	1.6	1.7	3.0	1.7	3.3	1.3	.7	6.0	—	.3	9.7	—	—	10	—	—	—
DDT	0.2%	8.0	2.0	—	5.7	2.0	2.3	2.3	2.7	.5	1.0	0.7	8.3	—	1.0	9.0	—	—	10	—	—	—
Lead arsenate		9.0	1.0	—	7.0	2.0	1.0	4.0	3.0	3.0	2.0	1.7	6.3	—	2.3	7.7	—	—	10	—	—	—
Control		10	—	—	10	—	—	10	—	—	10	—	—	10	—	—	10	—	—	10	—	—

[a] L—living; M—moribund; D—dead.

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(Formerly The Philippine Agriculturist and Forester)

Published by the COLLEGE OF AGRICULTURE
AND CENTRAL EXPERIMENT STATION
UNIVERSITY OF THE PHILIPPINES

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